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The effect of the Convention on International Trade in Endangered Species on scientific collections

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The Convention on International Trade in Endangered Species (CITES) was conceived in the spirit of cooperation, with the aim of ensuring that the international trade in wild animals and plants, including all parts and derivatives, did not threaten their survival. However, concerns have been raised by scientists that CITES hinders the cross-border movement of scientific specimens. To our knowledge, no empirical analysis has been undertaken to demonstrate the existence of this effect. We test for a CITES effect on the collection record of orchids from Brazil and Costa Rica using the collection records of bromeliads, which are not covered by CITES, as a control. Highly significant effects are found in both countries.

Keywords: Bromeliaceae; Convention on International Trade in Endangered Species; conservation assessment; Orchidaceae; specimens

1. INTRODUCTION

The landmark 1973 Convention on International Trade in Endangered Species (CITES) aims to ensure that the international trade in wild animals and plants does not threaten their survival. Although CITES has enjoyed undeniable success, a long-standing concern in scientific circles has been that CITES impedes the cross-border movement of scientific specimens (Koopowitz 2001; Roberts 2005; Zelenko 2005; McInerny *et al.* 2006; Raven 2007). This concern is heightened as other international conservation efforts—most notably the Convention on Biological Diversity (CBD)—move forward. In the case of CITES, the establishment of the Registered Scientific Institute (RSI) programme was intended to alleviate this problem. However, the impression remains that this programme, the implementation of which is typically left to individual states, does not work well, with only 36% of member states having registered institutes. Moreover, the establishment of an RSI is no guarantee that the movement of scientific specimens is unimpeded.

Despite concern over the effect of CITES on scientific collecting, to our knowledge, no empirical analysis has been undertaken to demonstrate the existence of this effect. The purpose of this paper is to present such an analysis. A natural way to test for a CITES effect is to compare collection rates before and after CITES went into effect. Performing such a comparison is difficult for at least two reasons. First, there is a paucity of data relating to collection rates. Secondly, variations in collection rates reflect factors other than CITES. To address the first problem, we compiled collection dates for all specimens of orchids (Orchidaceae) from Brazil (2339 specimens) and Costa Rica (9380 specimens) held at the Missouri and New York Botanical Gardens and associated herbaria. Brazil lacks an RSI while Costa Rica has one: the Lankester Botanic Garden, a renowned epiphyte research institution. It should be stressed that we are not making a comparison *between* Brazil and Costa Rica, but only comparisons *within* these countries. Orchids are the largest single group covered by CITES, representing approximately 75% of species covered by the agreement. As described in more detail below, to address the second problem, we incorporated into the analysis the parallel collection records of bromeliads (Bromeliaceae; Brazil, 1377 specimens and Costa Rica, 2365 specimens). With the exception of seven species not found within the geographical area of this study, bromeliads are not covered by CITES. However, because orchids and bromeliads are sympatric epiphytes, factors other than CITES, which affect collection rates, such as species declines due to habitat loss, are expected to be similar. In this sense, the collection record of bromeliads serves as a control for detecting a CITES effect in the collection record of orchids.

2. A TEST FOR A CITES EFFECT

The basic assumption of our analysis is that a CITES effect would express itself as a decline in the collection rate of orchids in relation to the collection rate of bromeliads occurring after ratification. While we assume that, loosely speaking, the collection processes for the two families are the same, we do not assume that they are necessarily collected together. Let $X(t)$ and $Y(t)$ be the number of specimens of orchids and bromeliads, respectively, collected in a country in year t and let $T(t)=X(t)+Y(t)$ be the total number of specimens collected in year t. Assume that, conditional on $T(t)$, $X(t)$ has a binomial distribution with $T(t)$ trials and success probability $p(t)$. This would be the case, for example, if $X(t)$ and $Y(t)$ were independent Poisson random variables with means $\lambda(t)$ and $\mu(t)$, respectively, in which case $p(t)=\lambda(t)/(\lambda(t)+\mu(t))$. The quantity $p(t)$, which we will refer to as the orchid probability, is the probability that a specimen selected at random from the $T(t)$ specimens collected in year t is an orchid. Let t_0 be the year in which CITES was ratified in

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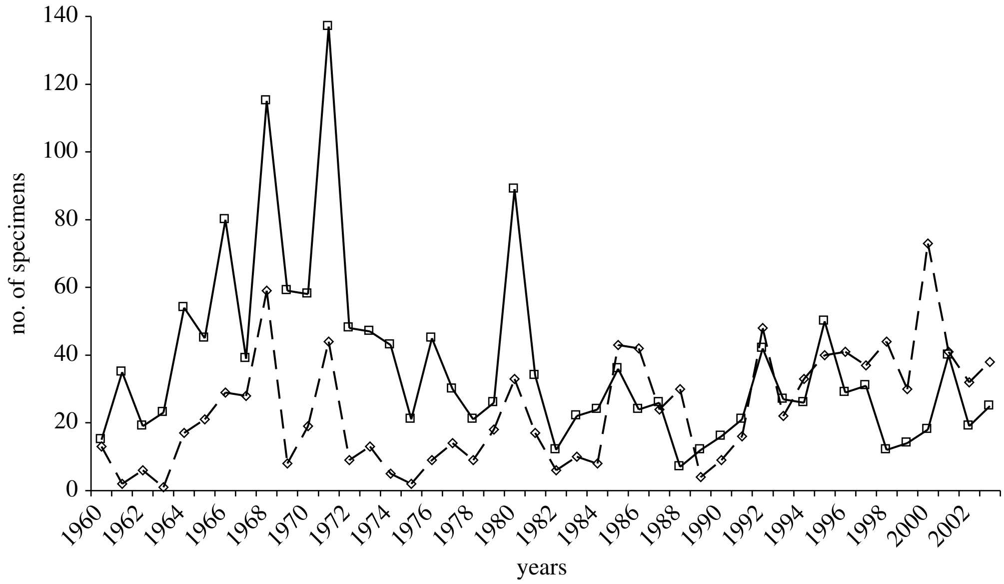

Figure 1. Annual time-series collection dates of specimens of orchids (solid line) and bromeliads (dashed line) from Brazil held by the Missouri and New York Botanical Gardens and associated herbaria, 1960–2003.

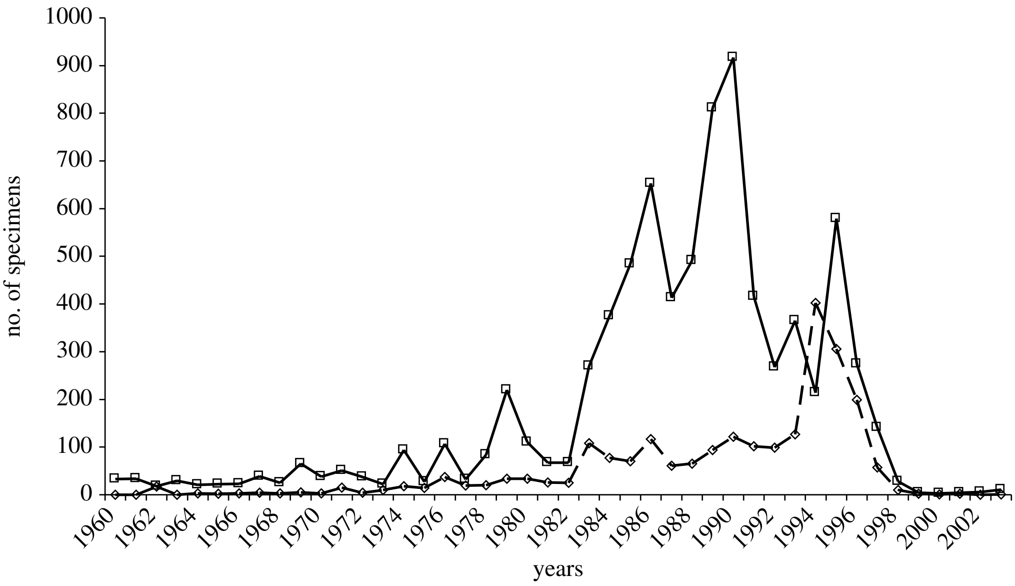

Figure 2. Annual time-series collection dates of specimens of orchids (solid line) and bromeliads (dashed line) from Costa Rica held by the Missouri and New York Botanical Gardens and associated herbaria, 1960–2003.

this country. The basic model adopted here for the orchid probability is

$$p(t) = \begin{cases} p_1 & t < t_0 \\ p_2 & t \geq t_0. \end{cases} \tag{2.1}$$

Under this model, interest centres on testing the null hypothesis $H_0 : p_1 = p_2$ of no change in the orchid probability against the one-sided alternative hypothesis $H_1 : p_1 > p_2$ of a decrease in the orchid probability following the ratification of CITES.

Let X_b and X_a be the total number of orchid specimens collected before and after CITES ratification, respectively. Similarly, let Y_b and Y_a be the total number of bromeliad specimens collected before and after ratification, respectively. A test of H_0 against the one-sided alternative H_1 can be based on the sample log odds ratio given by

$$\theta = \log \frac{X_b Y_a}{X_a Y_b}, \tag{2.2}$$

with large values of θ favouring H_1. Under H_0, θ is approximately normally distributed with mean 0 and approximate standard deviation

$$\sigma_0 \cong \sqrt{\frac{1}{X_b} + \frac{1}{X_a} + \frac{1}{Y_b} + \frac{1}{Y_a}}. \tag{2.3}$$

The null hypothesis is rejected at significance level α if $\theta/\sigma_0 > z_\alpha$, where z_α is the upper α-quantile of the standard normal distribution. Statistical inference based on the log odds ratio is discussed in Collett (1991).

3. RESULTS

The time series of $X(t)$ and $Y(t)$ over the observation period 1960–2003 for Brazil and Costa Rica is shown is shown in figures 1 and 2, respectively. The co-movement of these time series within each country presumably reflects common factors, such as collection effort, for which control is sought. CITES was ratified in both countries in 1975, so we take the value of t_0 to be 1976. For Brazil, the values of X_b, X_a, Y_b and Y_a are 838, 778, 276 and 771, respectively. Thus, prior to the ratification of CITES, roughly three orchid specimens were collected for each bromeliad specimen, while after ratification this number fell to 1. The corresponding value of θ is 1.10 with an approximate standard deviation under H_0 of 0.09. The value of θ/σ_0 is 12.1 which is significant at essentially any reasonable level. For Costa Rica, the values of X_b, X_a, Y_b and Y_a and are 578, 7414, 101 and 2217, respectively. In this case, prior to ratification, 5.7 orchid specimens were collected for each bromeliad specimen, while after ratification this number fell to 3.3. The corresponding value of θ is approximately 0.54 with an approximate standard deviation of 0.11. The value of θ/σ_0 is approximately 4.9 which again is significant at essentially any level. We can therefore conclude with high confidence that there has been a decrease in the orchid probability in Brazil and Costa Rica following the ratification of CITES in 1975.

4. DISCUSSION

The results of §3 must be interpreted with due caution. The collection rate of bromeliads is not a perfect control for factors unrelated to CITES, which affects the collection rate of orchids. Nevertheless, on balance, these results suggest that the concern that CITES has impeded scientific collecting cannot be dismissed (CITES effect). Impeding scientific collecting has consequences beyond science. The importance of biological collections held by museums and herbaria for conservation assessment and planning is now widely recognized (e.g. Ponder *et al.* 2001; Suarez & Tsutsui 2004; Nic Lughadha *et al.* 2005). Thus, the same conservation interests that underlie CITES would be served by ensuring freer movement of biological specimens for scientific purposes.

Although we have eschewed a cross-country comparison, it is worth noting that the estimate of the magnitude of the CITES effect for Costa Rica is smaller than that for Brazil. In part, this may reflect the fact that Costa Rica has an RSI while Brazil has none. If this is true, then it suggests that, provided it is implemented, this provision of CITES is valuable in protecting scientific collection. A modest recommendation is to promote the establishment of additional RSIs, particularly in countries that have none. As pointed out by Prathapan *et al.* (2006), actions of this kind will become increasingly important as new international conservation agreements, like the CBD, come into force.

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